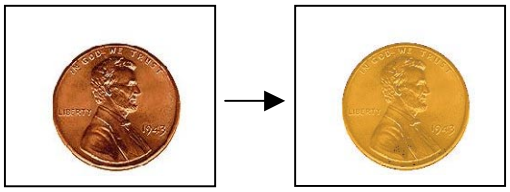
Activity # 14

Title: The Brass Penny-Teacher's Copy



(Lab teams of 2-3 students)

Note to the Teacher:

- This entertaining activity can be utilized when the topic of solutions is covered in your curriculum. It is guaranteed to become one of your students' (and YOUR!) favorites!
- Alloys (solutions of one metal dissolved in another) should be discussed prior to beginning this activity.
- See Activity #13 for a diagram/instructions on the operation of a Bunsen burner.
- This activity can be performed as a teacher demonstration if the inherent hazards create a safety issue regarding your laboratory conditions.
- A 6 molar solution of hydrochloric acid will have to be prepared in advance (Add concentrated 12M HCl to an equal volume of water to produce about 10 mL for each lab team).
- A 50% solution of sodium hydroxide must be prepared in advance (or use Frey Scientific, #15580188, sodium hydroxide solution (50%), $19.40, 1-800-225-FREY) to produce about 30 mL per lab team (The teams will have to replenish the NaOH solution throughout the lab.)

National Science Education Standards addressed:

Physical Science

CONTENT STANDARD B:
As a result of their activities in grades 5-8, all students should develop an understanding of

Properties and changes of properties in matter

GUIDE TO THE CONTENT STANDARD

Fundamental concepts and principles that underlie this standard include

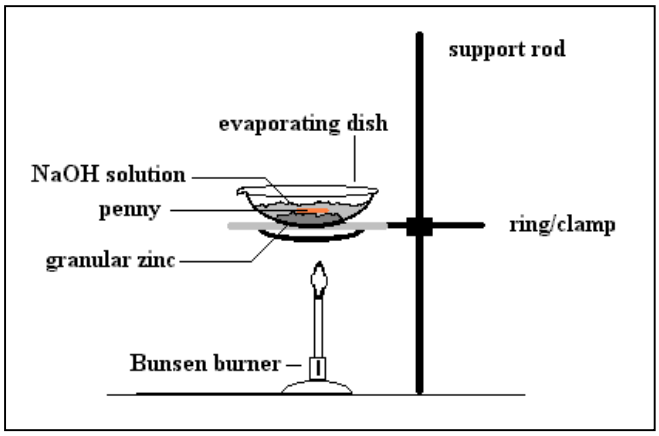
PROPERTIES AND CHANGES OF PROPERTIES IN MATTER

A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.

Purpose: To investigate the preparation of an alloy

Materials: dilute solution of hydrochloric acid (HCl) in beaker, dilute sodium hydroxide solution (NaOH) in flask, pipette for dispensing NaOH solution, granular zinc, pennies (the newer and cleaner the better!), evaporating dish, Bunsen burner, support rod, ring/clamp, wire gauze, tweezers, weighing dish, laboratory balance, baking soda, vinegar, magnet (optional) to test physical properties of the copper and the brass

Hazards/Precautions: Because of the use of a caustic base and a corrosive acid, safety goggles will be worn at all times. The wearing of aprons is mandatory. Sodium bicarbonate (baking soda) will be used to neutralize any acid spills and acetic acid (vinegar) will be used to neutralize any NaOH spills. Because of the use of open flames, long hair will be tied back and no coats or loose clothing will be worn.



Procedure: 1. Using your tweezers, carefully "etch" your penny by placing it into the HCl for a few seconds (until the coin appears bright).
2. Remove the penny from the acid with the tweezers and rinse it under running water.
3. Add 15.0 g of granular Zn to your evaporating dish and then add 15 mL of NaOH solution to completely cover the Zn. Using your tweezers, place the acid-etched penny on top of the Zn in your evaporating dish.
4. GENTLY heat the evaporating dish and contents over a "cool" burner flame until the entire penny acquires a silvery coating. This will require that the penny be turned over occasionally with the tweezers during this operation. Do not boil ...and do not allow the NaOH to splatter. Replenish the NaOH solution as necessary to make certain the penny is always covered with liquid. A cool flame is obtained by rotating the air collar on the Bunsen burner until the air-intake ports are closed.
5. Use tweezers to remove the penny by its edge from the dish and rinse clean under SLOWLY running water. DO NOT RUB OFF THE SILVERY COATING!
6. Grasp the penny by its edge with the tweezers and hold it in a cool burner flame... continuously flip-flopping it every second so that both sides of the penny are heated equally. Remove it from the flame as soon as the penny turns a bright gold color. **DO NOT OVERHEAT!** Allow your penny to cool on the edge of the wire gauze at your lab station or immediately hold it under cold water. Overheating could cause the zinc core of post-1982 pennies to melt…and splatter on the lab table creating an unnecessary hazard.
7. Teacher instructions will inform you as to the clean-up procedure for your lab stations.

FOLLOW-UP/CONCLUSIONS/ANALYSIS:
1. Define all five underlined words in the above text. (Hey, you may need a dictionary!)
2. Why must one be especially careful when using post-1982 pennies? When the cost of copper rose drastically in the early 1970's, a copper penny became more valuable as "scrap" than its one-cent monetary worth. Consequently, to devalue the penny, the U.S. Mint redesigned the cent with a zinc (lightweight, low melting point, inexpensive metal) core. Pre-1982 pennies made of high-density copper have an average mass of about 3.0 grams. Post-1982 pennies with low-density copper cores have an average mass of 2.6 grams. See Post-Lab Presentation as great follow-up demonstration for this activity.
3. What did the etching process appear to do to the penny?
4. What was the silvery substance that was produced on the penny in PROCEDURE step #4?
5. Why did the silvery penny turn gold in color after being heated in the burner flame?
6. Why was the heat even necessary to produce this change?

7. List two physical properties of zinc and two for copper. Students can be encouraged to use the magnet to test a FRESH sample of zinc (not one that has been used with the NaOH solution) for its magnetic properties.
8. What are the advantages of brass over either of the two metals of which it is composed?
9. Which metal do you think was the solvent and which was the solute in the metallic solution (alloy) prepared in this activity? Give a reason for your answer.
10. What could be done to preserve the luster of your "brass penny?"

Technology Integration:

- http://www.sma-inc.com/information.html -Nickel Titanium (also known as Nitinol) is in the unique class of materials known as **shape memory alloys**.
- http://www.iitm.ac.in/id110/id110/susyv/susy_2000.html - This lecture will take an overview of the role of various materials such as metals, ceramics and plastics and their properties in the design process.
- http://www.nsf.gov/od/lpa/news/publicat/nsf0050/materials/smallplanet.htm -A discussion of how materials synthesis research is being used to investigate new metal alloys

Post-Lab Presentation: Using a triangular file, cut four equally spaced notched around the outside of a post-1982 penny (deep enough to reach the zinc core within) as in the photo here. Now place the penny in a small beaker and add enough dilute hydrochloric acid (HCl…leftover from this lab) to cover the coin. Let stand for a couple of days and gently remove with forceps or tweezers. Rinse completely under running water. You are now holding the paper-thin copper shell previously encasing the zinc core! Where's the zinc? The zinc replaced the hydrogen in the HCl (This was the bubbles of gas seen rising from the notches.) in the balanced equation:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Note: Because traces of HCl may still be trapped within the thin copper shell of the coin, it is best NOT to pass the coin around the room to be handled with bare hands. Place the coin in a petri dish and instruct the students to handle the copper casing with the tweezers ONLY!